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Original Article

Relationship between metabolic syndrome and its components with bone densitometry in postmenopausal women

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ABSTRACT

Background: Prevention of osteoporosis and bone fracture and the relationship between metabolic syndrome and bone density are controversial issues.
The aim of this study: The aim of this study was to evaluate the association between metabolic syndrome and its components with bone mineral density in post menopausal women referred for bone mineral density (BMD) test.
Methods: A total of 143 postmenopausal women with at least one year of menopause experience participated in this cross-sectional study. Demographic and anthropometric characteristics for all participants were collected. Also, biochemical parameters including fasting blood sugar, Cholesterol (HDL and LDL), triglyceride were measured. Association between the components of metabolic syndrome and bone densitometry were analyzed by statistical methods.
Results: In this study, 72% of participants did not have metabolic syndrome. Among them, 43.4% and 28.7% had osteoporosis and normal density, respectively. Of remaining participants with metabolic syndrome, 12.6% and 15.4% had osteoporosis and normal density, respectively. Among the metabolic syndrome components, waist circumference, HDL cholesterol, and waist to hip ratio were significantly associated with bone mass ($P < 0.05$). Osteoporotic women had lower waist circumference and waist to hip ratio and higher HDL than women without osteoporosis. On the other hand, women with metabolic syndrome did not have significant differences than women without metabolic syndrome in terms of lumbar and femoral neck density ($P > 0.05$).
Conclusion: Results from this study showed that metabolic syndrome and its components did not induce bone mass loss. The discrepancies of the studies in this area call for more large scale studies in population so as to prevent women problems in this area.

1. Introduction

Metabolic syndrome refers to a set of conditions that occur together including high blood pressure, elevated insulin level in blood, increased body fat around the waist, high triglyceride, and low HDL cholesterol. Simultaneous existence of these conditions increases the risk of heart disease, stroke, and diabetic status [1,2]. The literature review shows that increasing CRP (a marker of systemic inflammation) is associated with osteoporosis and non-traumatic fractures [3]. Also, the metabolic syndrome is a disease that is associated with the presence of inflammation in the body [4]. Therefore, systemic inflammation associated with metabolic syndrome may activate bone resorption process that leads to reduced bone density [5]. On the other hand, other component of the metabolic syndrome (obesity or increased body mass index) is known as a protective factor against the development of osteoporosis [6]. Therefore, in patients with metabolic syndrome, simultaneous action of two factors with opposite effects on bone mineral density has been observed. These factors include obesity as a known protective factor against osteoporosis and inflammatory processes that activate bone resorption [1,5]. Previous studies have investigated the association between these factors and osteoporosis, but the results of these studies are inconsistent [7]. For example, the results regarding the relationship between high triglyceride and low levels of HDL cholesterol with bone mineral density (BMD) is incompatible. Moreover, there are conflicting reports about the relationship between high blood pressure and

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BMD [8,9]. While it seems that being overweight and obese protects the individual against bone loss while aging, studies have shown that abdominal obesity is associated with osteopenia and osteoporosis [10]. Some studies have mentioned hyperglycemia as a predictor of low bone mass or osteoporosis, but have not reached a definitive conclusion about its relationship with BMD [10,11]. Although the inflammation caused by metabolic syndrome can lead to a decrease in bone density, recent studies have reported that metabolic syndrome reduces the risk of non-costal bone fractures [8,12].

Due to the above mentioned reasons and the importance of prevention of osteoporosis and bone fractures, the relationship between metabolic syndrome and bone density is still a controversial issue. The aim of this study was to evaluate the association between metabolic syndrome and its components with bone density in women referred for bone mineral density (BMD) test.

2. Methods

This cross-sectional study was done in rheumatology department of a university hospital in Qazvin. One hundred forty three women aged between 39 to 87 years were enrolled from patients referred for bone densitometry. In this study, sampling was done through non-probability sampling method. This study was conducted in accordance with the research priorities of Qazvin University of Medical Sciences and was approved by the ethics committee of the university. Informed consent was taken from all patients. Inclusion criteria included all women who were referred for bone densitometry. Exclusion criteria were a history of rheumatic diseases such as rheumatoid arthritis in patients and use of corticosteroids. Structured medical interviews and medical examinations by rheumatologist were done for all patients. Women with diagnosis of osteoporosis in BMD test were considered as patients while those with normal result of BMD were considered as healthy women. The Bone Mineral Density was measured using dual-energy X-ray absorptiometry at lumbar spine and femoral neck (Hologic QDR 2000, Bedford, MA, USA model) [13]. Results of BMD were categorized according to the WHO criteria. According the WHO criteria, women with spine or femur neck T-score equal or below −2.5 were considered as having osteoporosis. T-score between −1 to −2.5 and more than −1 were considered as having osteopenia and normal people, respectively.

Other patients' information including age (year), height (meter), weight (kilogram), and years from menopause were recorded. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of weight. Waist and hip circumferences were measured at the level of the umbilicus and the symphysis of pubis, respectively. Also, the ratio between these two indices was calculated. Blood biochemical tests including fasting blood sugar, high density lipoprotein cholesterol, and low density lipoprotein cholesterol were done for all the participants. Women with and without a diagnosis of metabolic syndrome were considered as positive and negative exposure, respectively.

The diagnosis of metabolic syndrome was done using the criteria proposed by the Third Report of the National Cholesterol Education Program [14]. According to the criteria, diagnosis of metabolic syndrome requires three or more of the followings: waist circumference ≥88 cm; high blood pressure (systolic blood pressure ≥130 mmhg and diastolic blood pressure ≥85 mmhg); HDL cholesterol ≤50 mg/dl; and fasting blood sugar ≥100 mg/dl. Distribution of all anthropometric and laboratory data were evaluated. Data were presented using frequency and percentage for categorical variables. Chi-square test was used to compare qualitative variables, and independent *t*-test was used for compare continuous variables. All statistical analyses were performed using SPSS software version 19 and p-value less than 0.05 was considered statistically significant.

3. Results

A total of 143 women participated in this study. Among them, 80 (55.9%) patients suffered from osteoporosis, and 40 (28%) patients had metabolic syndrome. Table 1 compares results from anthropometric data and biochemical blood tests between patients with normal bone density and osteoporosis. As seen in Table 1, variables including age, waist circumference and waist-hip ratio was significantly different in those with normal bone density than osteoporotic patients (P-value < 0.05).

The mean age of the patients with normal bone density was 33/7 ± 47/53, compared to 21/8 ± 03/60 in osteoporotic patients. This difference was statistically significant (P = 0.001). Also, mean waist circumference in normal bone density and osteoporotic group was 101.6 ± 9.1 and 95.9 ± 11.9, respectively. Its difference was statistically significant (P = 0.002) as well. In relation to blood biochemical parameters, only HDL cholesterol was significantly higher in osteoporotic women than those with normal density (P = 0.031).

Analysis of variables in this study was also performed using criteria proposed by NCEP (ATPIII). As seen in Table 2, twenty two women had a waist circumference less than 88 centimeters, among which, 19 (13.3%) patients suffered from osteoporosis and 3 (2.1%) patients had normal bone density. On the other hand, one hundred twenty one women had a waist circumference higher than 88 centimeters, among which, 61 (42.7%) patients suffered from osteoporosis and 60 (42%) patients had normal bone density. This difference were analyzed using chi-square test and was meaningful (P = 0.002). Another significant variable in the results was HDL cholesterol. Twenty four women of the total participants had HDL cholesterol level of ≤50, among which, 13 (9.09%) and 11 (7.69%) were osteoporotic and normal women, respectively (P = 0.031). Results for other biochemical parameters (fasting blood sugar and triglyceride) and blood pressure are shown in Table 2. Overall, as it

Table 1
comparison results from anthropometric data and biochemical blood tests between patients with normal bone density and osteoporosis.

	Normal bone density (n = 63)	Osteoporosis (n = 80)	P-value
Waist circumference (cm)	101.58 ± 9.15	95.92 ± 11.97	0.002*
Waist to hip ratio	0.92 ± 0.9	0.88 ± 0.86	0.002*
Systolic blood pressure (mmhg)	121.74 ± 19.55	119.45 ± 18.29	0.471
Diastolic blood pressure (mmhg)	74.12 ± 13.29	70.5 ± 14.31	0.124
Fasting blood sugar (mg/dl)	112.11 ± 49.55	102.91 ± 30.71	0.175
HDL (mg/dl)	50.33 ± 11.76	55.03 ± 13.55	0.031*
LDL (mg/dl)	113.41 ± 32.76	116.3 ± 35.28	0.617
TG (mg/dl)	153.5 ± 72.02	133.8 ± 65.96	0.091
Age (years)	53.47 ± 7.33	60.03 ± 8.21	0.001*
BMI (kg/m2)	31.61 ± 7.95	33.64 ± 9.22	0.75

* p < .05 instudent *t*-test used for comparison between groups.

Table 2
comparison between patients with normal bone density and osteoporosis in terms of NCEP parameters.

	Normal bone density	Osteoporosis	p-value
Waist circumference (cm)			0.002*
<88	3 (2.1%)	19 (13.29%)	
> = 88	60 (41.96%)	61 (42.66%)	
Fasting blood sugar (mg/dl)			0.144
<100	35 (24.48%)	54 (37.76%)	
> = 100	28 (19.58%)	26 (18.18%)	
HDL (mg/dl)			0.031*
> = 50	52 (36.36%)	67 (46.85%)	
<50	11 (7.69%)	13 (9.09%)	
TG (mg/dl)			0.079
<150	36 (25.17%)	57 (39.86%)	
> = 150	27 (18.88%)	23 (16.08%)	
Blood pressure (mmhg)			0.542
<130/85	52 (36.36%)	69 (48.25%)	
> 150	11 (7.69%)	11 (7.69%)	
Metabolic syndrome			0.1
Yes	41 (28.67%)	62 (43.36%)	
No	22 (15.38%)	18 (12.59%)	

* $p < .05$ inchi-square test used for comparison between groups.

can be seen in Table 2, 103 women (72%) of the participants did not have metabolic syndrome including 62 osteoporotic women and 41 subjects with normal bone density. It should be noted that according to the results of the chi-square test, no significant difference was observe between the groups with and without metabolic syndrome in terms of developing osteoporosis (P = 0.1).

Table 3 compares bone mineral density in two part of body (lumbar spine and neck of femur) based on presence or absence of metabolic syndrome in the participants. All bone density results are presented based on g/cm2. Women with metabolic syndrome had slightly higher T-score and BMD than women without it, but this difference was not statistically significant (P-value > 0.05).

4. Discussion

Since there was a few information about the prevalence of metabolic syndrome in osteoporotic women in Qazvin province, this study evaluated the prevalence and most common features of metabolic syndrome in osteoporotic women referred to bone densitometry center. The findings were similar to other studies which have shown that metabolic syndrome cause a slight increase in bone density [13]. Other results showed that the prevalence of osteoporosis in women with metabolic syndrome was lower than those without it. However, this difference was statistically significant in some parameters. In a study conducted by Kinjo et al. similar results were found [15].

The most important parameters of metabolic syndrome which were associated with bone densitometry included the mean of waist circumference, mean HDL cholesterol, and waist to hip ratio. Also, the mean age of patients with normal bone density was lower than those with osteoporosis. The results of previous study have shown that prevalence of metabolic syndrome and osteoporosis in women increases with age. Finally, these diseases lead to poor quality of life and increased morbidity and mortality in older age [7].

In this study, mean serum HDL in women with normal bone mineral density was significantly lower than in women with osteoporosis. While in another study conducted in 2010 in Korea, serum HDL level were positively associated with BMD and protected women against osteoporosis [16]. Kim and colleagues also found similar results that are inconsistent with the results of present study [17]. As mentioned earlier, existing reports on the level of HDL and BMD are conflicting and therefore these differences need further investigations [8,9].

In our study, the mean of waist circumference and waist to hip ratio in women with normal bone mineral density was significantly higher than women with osteoporosis. These results are consistent with a study conducted by Alissa and colleagues [8], and is contrary to Kim's study [17]. Thus it can be stated that in this study waist circumference (among other parameters of metabolic syndrome) were significantly associated with bone densitometry.

The literature review shows that obesity act as a protective factor against bone loss in older people. Accumulation of abdominal fat is also one of the main features of the metabolic syndrome that is often associated with obesity [18].

Similar to another study that was conducted in this area, it was expected that lower values of fasting blood sugar are seen in subjects with normal bone density than those with osteoporosis [17,19]. Such relationship; however, was not achieved in present study.

In this study, significant association was not observed between BMD results with systolic and diastolic blood pressure that was consistent with other study conducted by Mussolino et al. [20] while other studies have reported the existence of this relationship, especially in diastolic blood pressure. The exact reason for this relationship is not clear, yet changes in serum concentration of PTH or urine calcium exertion has been described as the main cause [20,21].

In this study, the mean level of triglyceride was greater than the osteoporotic individuals. But, the difference was not statistically significant. It seems that triglyceride level is associated with BMD especially at the hip region [16]. This is not common in all studies, because only some studies have shown that triglyceride level is effective in reducing the risk of fracture [19].

The BMI (body mass index) is known as one of the strongest predicting factor for BMD [16], but in this study, no significant correlation was found between these two factors.

Although the significant differences in bone density between subjects with and without metabolic syndrome were reported in this study, it can be said that metabolic syndrome did not have a detrimental effect on bone health. Also, the role of protective mechanisms for bone density in this syndrome is more prominent than its negative effects due to inflammation on bone mineral density. Other studies also suggest a protective role of metabolic syndrome on bone density [13].

Table 3
results of bone densitometry according suffering from metabolic syndrome.

Bone densitometry parameters	Without MS (n = 103)	With MS (n = 40)	P-value
BMD spine (g/cm2) L1-L4	0.96 ± 0.15	0.99 ± 0.16	0.29
T-score in lumbar spine	−1.12 ± 1.3	−0.68 ± 1.3	0.07
BMD femoral neck (g/cm2)	0.79 ± 0.12	0.81 ± 0.12	0.37
T-score in femoral neck	−1.11 ± 1.1	−0.87 ± 0.99	0.23

student *t*-test used for comparison between groups.

So, as mentioned earlier, the relationship between metabolic syndrome and bone density is a controversial issue, and the differences between other studies and the present research is justified. Further research in this field particularly on the pathophysiologic effects of metabolic syndrome on bone density seems necessary.

In the present study, as well as other cross sectional studies, determining a causal relationship between metabolic syndrome with BMD was difficult. Although, all participants were selected from one bone densitometry center, but it is necessary to note that the center was the only densitometry center at the time of the study. Little research has been done on the subject of this study in Qazvin province, so this study could be a starting point for further epidemiological study in this field.

5. Conclusion

The present study showed that some parameters of metabolic syndrome including waist circumference, waist to hip ration, and serum HDL are significantly associated with bone mineral density. Considering the inconsistent results in this area, more well-designed studies should be conducted to confirm the relationship between metabolic syndrome and its component with bone densitometry.

Conflict of interest

No conflict of interest for all authors.

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